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integrals affords us a new class of results, which I next consider. A continental mathematician, M. Smaasen, has given, in a recent volume of Crelle's Journal, certain methods of combining series together which give us the means of reducing various multiple integrals to single ones. The series hitherto considered are what have been denominated "factorial series;" but, lastly, I proceed to show that analogous processes extend to series of a very complicated nature and of an entirely different form, and for that purpose sum by means of definite integrals certain series, whose values are obtained in finite terms in the "Exercices des Mathématiques" by means of the Residual Calculus. The total result will be the evaluation of an enormous number of definite integrals on an entirely new type, and the application of definite integrals to the summation of many intricate series.

November 30, 1854.

Anniversary Meeting. A Report of the Proceedings will appear in a future Number.

December 7, 1854.

Colonel SABINE, V.P., in the Chair.

The Chairman announced that the President had appointed the following noblemen and gentlemen Vice-Presidents for the ensuing year:—

The Earl of Rosse, K.P., M.A.

Colonel Sabine, R.A.

Sir Benjamin Brodie, Bart.

Thomas Bell, Esq.

Charles Darwin, Esq., M.A.

Charles Wheatstone, Esq.

Robert Hunt, Esq., was admitted into the Society.

The following communications were read :—

- I. “On the Attraction of the Himalaya Mountains, and of the elevated region beyond them, upon the Plumb-line in India.” By the Venerable JOHN HENRY PRATT, M.A., Archdeacon of Calcutta. Communicated by the Rev. Professor CHALLIS, M.A., F.R.S. &c. Received October 23, 1854.

The author commences by observing that it is now well known that the attraction of the Himalaya Mountains, and of the elevated region beyond them, has a sensible influence on the plumb-line in North India. This circumstance was brought to light during the progress of the great trigonometrical survey of that country. It was found by triangulation that the difference of latitude between the two extreme stations of the northern division of the arc, namely Kalianpur and Kaliana, is $5^{\circ} 23' 42'' \cdot 294$, whereas astronomical observations show a difference of $5^{\circ} 23' 37'' \cdot 058$, which is $5'' \cdot 236$ less than the former.

That the geodetic operations are not in fault, appears from this; that two bases, about 7 miles long, at the extremities of the arc having been measured with the utmost care, and also the length of the northern base having been computed from the measured length of the southern one, through a chain of triangles extending about 370 miles, the difference between the measured and the computed lengths was only 0·6 of a foot, which would produce, even if wholly lying in the meridian, a difference of only $0'' \cdot 006$ in the latitude.

The difference $5'' \cdot 236$ must therefore be attributed to some other cause. A very probable cause presents itself in the attraction of the superficial matter which lies in such abundance on the north of the Indian arc. It is easily seen that this disturbing force acts in the right direction, that is, it diminishes the difference of astronomical latitude between the two stations. Whether the cause here assigned will account for the error in the difference of latitude in *quantity* as well as in direction, is the question which the author proposes to discuss in the present paper.

It might seem at first sight that if mountain attraction were so influential as is here supposed, it would disturb the geodetic operations, since in observing the altitude or depression of one station as seen from another, the error in the plumb-line must come into calculation. The author shows, however, by mathematical calculation, that the effect of mountain attraction on the geodetic operations is perfectly insensible, so that it is clearly the astronomical operation of finding the difference of latitude that requires the correction. This is further apparent from the results obtained by Colonel Everest on attempting to determine the azimuths of the arc at seven stations *astronomically*.

To show the importance of considering mountain attraction in the delicate problem of the figure of the earth, the author investigates the effect of a small error in the difference of latitude of the extremities of an arc on the deduced value of the earth's ellipticity. As two unknown quantities occur in the determination of the spheroid of revolution which most nearly agrees with the earth, namely a the equatorial radius and ε the ellipticity, two arcs are required in order to determine them. The author selects the Russian arc, measured near North Cape, as the most advantageous with which to combine the northern portion of the Indian arc, and shows that an error of $5''\cdot236$ in defect in the amplitude of the latter would diminish the value of the ellipticity resulting from the two by about the $\frac{1}{2\cdot5}$ th part of the whole. If the effect of mountain attraction be as great as the author calculates it to be, ($15''\cdot885$ in the northern portion of the Indian arc,) the ellipticity would be diminished by $\frac{1}{8}\varepsilon$, and even by as much as $\frac{1}{6}\varepsilon$ if the whole Indian arc from Kaliana to Damargida were employed.

The author then proceeds, first to develop his method of calculation, and then to reduce his formula to numbers, according to the best data which he was able to collect.

An expression is first investigated for the horizontal attraction of a prism of the earth's crust standing on a given small base, having a small height, and situated at a given angular distance (measured from the centre of the earth) from the station, A, at which the attraction is sought. In the cases to which this expression is employed

it reduces itself without sensible error to

$$\frac{M}{a^2} \cos \left(\frac{1}{2} \theta \right),$$

where M is the attracting mass, a the chord joining its base with A , and θ the angle subtended by this chord at the earth's centre.

In applying this expression to the problem in hand, the author divides the earth's surface into lines, by vertical planes passing through at equal angular distances. These lines are further subdivided by small circles having A for their common pole, and in this manner cutting the whole surface into curvilinear quadrilaterals. He then investigates what the law of dissection must be, that is, according to what law the radii of the small circles must be taken to increase, in order that the horizontal attraction of the portion of the crust standing on one of the quadrilaterals may be equal to the product of its average height and density by a constant quantity, independent of the distance of the quadrilateral from A . If α and $\alpha + \phi$ be the angular radii of two consecutive small circles, there results

$$\frac{\phi \cos^2(\frac{1}{2}\alpha + \frac{1}{4}\phi)}{\sin(\frac{1}{2}\alpha + \frac{1}{4}\phi)} = \text{a constant quantity} = c.$$

To fix the value of this constant, the author assumes $\phi = \frac{1}{10} \alpha$ when ϕ and α are indefinitely small, which gives $c = \frac{4}{21}$. The above equation may then be solved numerically with sufficient approximation. In this manner a table is calculated of the radii of the successive small circles.

These distances should be laid down, and the circles drawn, on a map or globe, as well as the lines dividing the surface into lines. Nothing then remains to be done but to ascertain the average heights of the masses standing on the compartments thus drawn.

The author's paper was accompanied by a plate representing an outline of the continent of Asia. On this was laid down a polygonal figure DEFGHIJKL, (which for convenience the author calls the "enclosed space,") marking the boundary of an irregular mass, which is the only part of the earth's surface that appears to have a sensible effect on the plumb-line in India. The boundary of this space is thus defined:—

DEF is the Himalaya range, having a bend at E from north-west

on the left, to east-by-south on the right. FG is a range running to the table-land of Yu-nan in lat. 25° and long. 103° . GH is the range of the Yun-Ling mountains, in which there are many peaks of perpetual snow. HI is the Inshan range. IJ is the Khing-khan range, very steep on the east side, not so on the west; the passes are said to be 5525 feet above the sea. JK is the Altai range, the highest peak of which is 10,800 feet; the average height is 6000: the range declines towards the east. KL was once thought to be a range of mountains, but is now found to be a line of broken country. LD is the Bolor range, rising to an elevation similar to that of the Hindoo Koosh. There are besides these two ranges of mountains running into the enclosed space, parallel to the Altai and Southern Himalayas, namely the Thian-Schan range, or Celestial Mountains, and the Kuen-Luen range, being a continuation of the Hindoo Koosh, which rises from an altitude of 2558 feet near Herat to about 20,000 where it meets the Bolor range. It is, however, with the elevation of the enclosed space itself that we are principally concerned, since ranges of mountains have not so important an influence, when distant, as table-lands of elevation.

Before describing the country within these limits, the author gives a general sketch of the parts which lie outside, from which it appears that the calculations may be confined to the enclosed space. He then describes in detail the nature of the country within the boundaries of the enclosed space, commencing with the Himalayas, which rise abruptly from the plains of India to 4000 feet and more, and cover an extensive broken space some 100 or 200 miles wide, rising to great heights; perhaps 200 summits exceed 18,000 feet; the highest reaches to more than 28,000. The general base on which these peaks rest rises gradually to 9000 or 10,000 feet, where it abuts on the great plateau north of the range. The character of the country to the south of this plateau is much better known than that to the north. If a circle with a radius $5^{\circ}046$ (the value of one of the radii employed in the dissection) be drawn around Kalia, it will pass over the highest part of this plateau. This circle divides the enclosed space into two portions, of which the southern is called by the author the "Known" and the northern the "Doubtful Region." The effects of the two portions are separated in the calculation by the introduction of an arbitrary factor.

After describing the doubtful region, as far as was possible from

the data to which he had access, the author assumes, as the best general representation of the facts, that to the north of a line running through Leh and H'Lassa the doubtful region slopes gradually from 10,000 feet down to 2500 along a parallel line nearly in its centre, and then rises again at the same angle to the north, and that the portion to the south of the line first mentioned, and not included in the known region, slopes at four times that rate.

The author then proceeds to numerical summations replacing an integration to be extended over the whole of the enclosed space. The breadth of the lines employed in the calculation is taken at 30° , which is shown not to be too large to give good results. The following are the results obtained :—

	Arising from		Total.
	Known region.	Doubtful region.	
Station A, Kaliana.			
Deflexion of plumb-line in meridian	12"·972	14"·881	27"·853
Correction of same for every 100 feet of change in heights }	0·312	0·260	
Deflexion of plumb-line in prime vertical }	8·136	8·806	16·942
Station B, Kalianpur.			
Deflexion in meridian	3·219	8·749	11·968
Correction for 100 feet	0·059	0·158	
Deflexion in prime vertical	0·789	3·974	4·763
Station C, Damargida.			
Deflexion in meridian	1·336	5·573	6·909
Correction for 100 feet	0·022	0·100	
Deflexion in prime vertical	0·000	2·723	2·723

whence there results,

Total deflexion at A = $32^{\circ} \cdot 601$, and in azimuth $31^{\circ} 18'$ East.

Total deflexion at B = $12^{\circ} \cdot 880$, and in azimuth $21^{\circ} 42'$ East.

Total deflexion at C = $7^{\circ} \cdot 426$, and in azimuth $21^{\circ} 31'$ East.

Difference of meridian deflexions at A and B = $15^{\circ} \cdot 885$.

Difference of meridian deflexions at A and C = $20^{\circ} \cdot 944$.

Difference of meridian deflexions at B and C = $5^{\circ} \cdot 059$.

The first of these differences is considerably greater than $5^{\circ} \cdot 236$, the quantity brought to light by the Indian Survey.

The author then examines these values more minutely, and considers the effect of various hypotheses for reducing them.

In the first place, the density of the attracting mass may have been assumed too large. The density assumed is 2.75 that of distilled water, the value assumed as the mean density of the mountain Schehallien in the calculations of Maskelyne. This can hardly be too great, but at any rate no remarkable supposition relative to the density can reduce the attraction by more than a small fraction of the whole.

Next, the mass of the doubtful region may have been assumed too great. This hypothesis is then examined by the author, who concludes that even the extravagant supposition of the non-existence of that region will not reduce the difference of meridian deflexions at A and B lower than to $9''.753$.

A third means of reduction may be looked for in the known region. A large part of the attraction belonging to this region arises from the Great Plateau. It would be necessary to cut down this plateau as much as 6000 feet to reduce the deflexions at A and B to $5''.236$, even were the whole mass on the doubtful region non-existent; so that it appears to be quite hopeless, by any admissible hypothesis relative to heights, densities, &c., to reduce the calculated deflexion so as to make it tally with the error brought to light by the survey.

After entering into some elaborate calculations confirmatory of the previous results, the author concludes by calculating the form of the Indian arc, that is, by determining what spheroid of revolution,—the axis of revolution being the earth's axis,—would most nearly coincide with that arc without reference to the rest of the earth, the data employed being the lengths and amplitudes of the northern and southern portions of the arc, and of course their sum, and likewise the latitudes, or at least approximate latitudes, of the middle points of the arcs. By using the amplitudes uncorrected for mountain attraction, the author obtains for the value of the ellipticity deduced from the Indian arc alone $\frac{1}{196.3}$, nearly agreeing with $\frac{1}{191.6}$, which is Col. Everest's result; but by using the amplitudes corrected for mountain attraction according to the author's calculation, the ellipticity is reduced to $\frac{1}{426.2}$. He concludes that the arc is more curved than it would be if it had the mean ellipticity of the earth, and

regards the supposition of a general deviation of the earth's surface in that region from the mean spheroidal form as the most satisfactory mode of accounting for the discrepancy.

II. "On the Value of Steam in the Decomposition of neutral Fatty Bodies." By GEORGE WILSON, Esq. Communicated by WARREN DE LA RUE, Esq. Received November 30, 1854.

In the course of a long series of experiments conducted on a large scale, the author has observed that the so-called neutral fatty bodies may be resolved, without danger of injurious decomposition, into glycerine and fatty acids, provided the still is maintained at a uniform high temperature, and that a continuous current of steam is admitted into it.

The temperature required to effect the splitting of the fats into their proximate elements varies with the nature of the body itself, but all hitherto tried may be resolved into glycerine and fatty acid at a temperature of 560° Fahr., many at much below that temperature. At a further period it is the author's intention to lay before the Society a detailed account of his experiments, with the confirmatory analyses, but in the mean time he states that palm oil, coconut oil, fish oil, animal tallow, Bornean vegetable tallow, "Japan vegetable wax" (more properly tallow), and several others have yielded satisfactory results, the fatty acid and glycerine distilling over together, but no longer in combination, and separating in the receiving vessel.